DETECTION OF' NEW DISSOCIATIVE ATTACHMENT CHANNELS IN NO

O. J. Orient and A. Chutjian

Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109

Three dissociative electron attachment channels have been detected and identified in NO *via* measurement of the $O^-(^2P)$ fragment energy. In addition to the known channel to produce $N(^2D)$ -t $O^-(^2P)$ [1], two new channels $N(^4S^0)$ + $O^-(^2P)$ and $N(^2P^0)$ + $O^-(2P)$ were detected, Cross sections for each of the channels are reported by normalizing the scattering intensities to total cross sections. The experimental approach uses solenoidal magnetic confinement of the electrons and ions, and trochoidal energy analysis of the low-energy ions.

The apparatus used to form O^- and measure the ion energies and intensities was used to generate intense beams of ground-state $O(^3P)$ atoms in fast atom-molecule and atom-surface collisions studies [2]. The entire experiment is carried out in a uniform, solenoidal, 6T magnetic field. Briefly, electrons are extracted from a hot tungsten filament, accelerated to the range 7.5-10.0 eV, and attach to a beam of NO. The resulting O^- ions are collected, and deflected in a trochoidal monochromator *TM* to separate them from the faster electrons. Electrons are collected in an electron Faraday cup. The spiraling ions are transported through two slits, a shielded cage, and detected in an analog mode in an **ion Faraday** cup. The ion current is then digitized and stored in a PC as a function of the *TM* electric field. Typical electron and ion currents are 10-5 A and 10-9 A, respectively. This is a new experimental approach which can be used to study a variety of electron attachment-ionization processes,

Energy spectra and relative attachment intensities of the O^- ions resulting from DA to NO are shown in Fig. 1 at three electron energies E_e. Each of the three features was deconvolved from the measured spectrum. The total relative attachment intensity $I(E_e, E_i)$ measured in FC_i is given by the sum over the final S, D, and P states, where the three components are deconvolved using Gaussian line shapes.

To treat the dynamics of the DA process, we regard the N and O^- fragments as emerging from a case where the center-of-mass (CM) energy is zero. The O^- fragment has a laboratory (LAB) energy given in Eq. (1), where M is the total mass of NO, E_o the incident NO energy, and θ the CM angle of the departing O^- ion relative to the CM velocity along the incident NO direction, ΔE_{CM} is the total CM energy available for fragment translational energy. One may use Eq. (1) to calculate the LAB energy of O^- and compare it to measurements. Shown in Fig. 1 above each feature are the ranges of calculated energies possible **in the collision** [Eq. (1)], with θ taken in the entire CM interval (O, π). In addition, the available CM energy will depend on the energy width of the electron beam. Using a width of about 2.5 kT = 0.4 eV (FWHM) one obtains a slightly larger range of possible O^-

$$AE_o = -\frac{\mu}{m_O} \Delta E_{CM} + \cos\theta \sqrt{\frac{4\mu}{M} E_o \Delta E_{CM}}. \qquad (1)$$

energies, given by the shaded additions in Fig. 1.

Cross sections as a function of E_e for each of the three channels are obtained by normalization to available total ion-yield measurements.
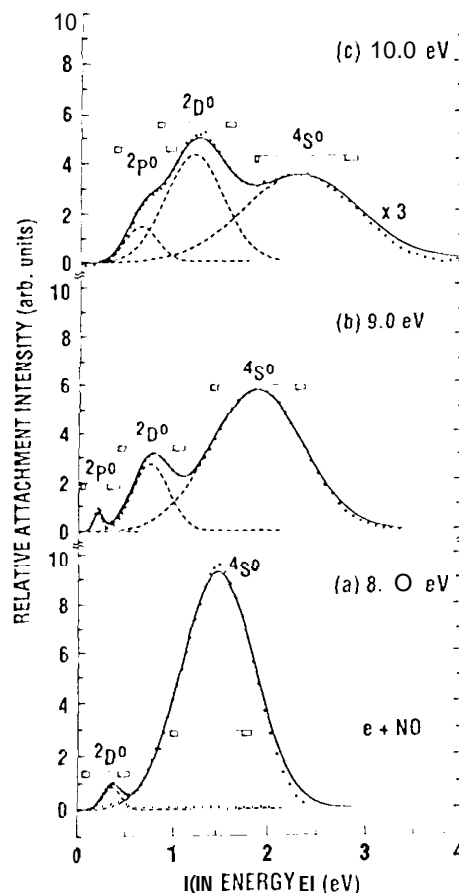

Figure 1. **Energy** spectra of the $O^-(^2P^0, ^2D^0, ^4S^0)$ ions at electron energies of (a) 8 eV, (b) 9 eV, and (c) 10 eV.

References

[1] **P. J. Chantry,** *Phys. Rev* **172, 125 [1968).**
[2] **O. J. Orient, K. E. Martus,** A. Chutjian **and E.** Murad, *Phys. Rev.* A **45, 2998 (1992).**